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BACTERIOLOGICAL STUDY

OF THE NEW ORLEANS EAST INCINERATOR

A Solid Waste Research
Open-File Report

written by
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U.S. ENVIRONMENTAL PROTECTION AGENCY
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1971

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INTRODUCTION

One sample each of domestic refuse, residue, quench water, stack emissions, fly ash, and well water used for quenching were taken daily for three consecutive days from the New Orleans East Incinerator Plant. Sampling and testing was done during the Mardi Gras season of 1969 in conjunction with the Division of Technical Operations study of this incinerator. The incinerator was evaluated by various technical specialists in engineering, chemistry, and bacteriology. This report is a bacteriological evaluation of the incinerator.

One important bacteriological criterion of incinerator efficiency involves the extent of bacterial destruction from the incoming refuse. A comparison of the quantity of total bacteria in refuse and in residue is used as a bacteriological parameter for judging incinerator efficiency.

Data contained herein on bacterial standard plate counts and aerobic and anaerobic spores under standard time-temperature of incubation are compared with data involving Cincinnati - Chicago incinerator studies (Peterson & Stutzenberger[6]) and a Memphis incinerator study (Armstrong, Klass, and Peterson[2]). The method used for the isolation and identification of total and fecal coliforms was the Membrane Filter technique (MF). For the detection of salmonellae, an elevated temperature technique was employed, enhancing the chances of isolating this organism from highly contaminated materials (Spino[7]) (Harvey & Price[5]).

PROCEDURE

Field Sampling

Samples of refuse, residue, and fly ash were taken using sterile tongs and placing the material into sterile plastic containers. The quench water and well water were taken from taps, aseptically in a sterile bottle as one would sample drinking water. Stack emission samples were taken or described by Armstrong (3) using a portable sampler.

Laboratory Technique

Two hundred grams of refuse or residue samples were homogenized in a Waring Blender containing 1800 ml of phosphate buffered water for 15 seconds (Peterson & Stutzenberger[6]).

Serial ten fold sample dilutions in sterile phosphate buffered water were made from the 10^{-1} through 10^{-7} after homogenization. For the refuse, 0.1 ml aliquots from 10^{-3} to 10^{-7} resulting 10^{-4} to 10^{-8} dilutions were pipetted into petri dishes for the standard pour plate bacterial count using Baltimore Biological Laboratories (BBL) Trypticase Soy Agar (TSA) and onto the surface of prepared 5% sheep blood agar plates for the propagation of fastidious organisms such as those found in the respiratory tract of man. For preparation of the pour plates, the inocula and the cooled TSA were mixed by gentle rotation, whereas the surface inocula on the blood agar plates was spread with the use of a glass sterile "Hockey" stick. Ten ml aliquots of each dilution were also transferred to tubes and heated in a water bath at 80°C for 15 minutes for testing of spore formers (Peterson and

Stutzenberger[6]). In addition to aerobic spores, anaerobic spores were determined by use of anaerobic jars and GAS-Paks (BBL Products). One ml aliquots of the initial dilutions used for standard plate count and pathogen isolation, were filtered through membrane filters of 0.45 porosity for the quantitation of total and fecal coliforms (Anon. 1). The same procedure was used for the residue, except that only 10^{-1} through 10^{-3} dilutions were used.

In order to isolate salmonellae, 30 grams of either refuse or residue were placed into 300 ml of two different enrichment media, tetrathionate and SBG-Sulfa, and incubated at 41°C for 18 hours. (Spino[7]) (Harvey and Price[5]). After incubation, the enrichments were streaked onto selective enteric plates containing Brilliant Green Agar and they were also incubated at 41°C for 18 hours. Suspected salmonellae colonies were tested for biochemical and serological reactions (Hajna[4]). Selective cultures were sent to the Communicable Disease Center, Atlanta, Georgia for serological typing of the salmonellae species.

The same tests were used for quench water as for the refuse and residue using 10^{0} to 10^{-6} dilutions for standard plate count, aerobic and anaerobic spore formers, fastidious bacterial pathogens, and coliforms. Thirty ml aliquots of quench water were inoculated into each enteric enrichment media for salmonellae isolation. The well water, the source of water used for quenching, was tested in a similar manner, except that the salmonellae determination was not performed.

The fly ash was tested for standard plate bacterial count, aerobic and anaerobic spore formers, and for respiratory pathogens. One gram samples of fly ash was placed into 9 ml of buffered water from which 1 ml and 0.1 ml aliquots were tested.

Stack sampling was carried out as described by Armstrong[3], and tested for standard plate counts, aerobic and anaerobic spore formers, and organisms associated with respiratory infections. The stack sampling device was calibrated to sample 0.62 ft^3/minute and was run for 5 minutes for each sample, therefore, a total of 3.1 ft^3 of stack gases was forced upon 300 ml of buffered water. If bacteria were present, they would have been impinged into the buffered water. After sampling, 100 ml of the "inoculated" buffered water was filtered through a membrane filter. The filter was then placed upon a Trypticase Soy Agar (TSA) plate and incubated at 35°C for 18 hours.(under standard time and temperature). One ml samples of the "inoculated" buffered water were tested for aerobic and anaerobic spore formers and bacterial pathogens as previously described.

RESULTS

The results of the study are shown in Tables I and II. With the exception of the Salmonella and fastidious pathogens, the results are quantitative as well as qualitative, showing actual observation of culture media and the calculated count. The plate counts for refuse and residue samples in Table I were converted to log values as shown in Table III. The log values of the standard plate bacterial

TABLE I - BACTERIOLOGICAL DATA ON INCINERATION STUDY
NEW ORLEANS, LA. 2/10,11,12/69

		STANDARD COUNT		AEROBIC SPORES		ANAEROBIC SPORES	
		Plate Count	Calculated Count	Plate Count	Calculated Count	Plate Count	Calculated Count
REFUSE	2/10	40 at 10^{-7}	4.0×10^{8}/g	9 at 10^{-4}	9.0×10^{4}/g	75 at 10^{-2}	7.5×10^{3}/g
	2/11	210 at 10^{-5}	2.1×10^{7}/g	35 at 10^{-3}	3.5×10^{4}.g	16 at 10^{-3}	1.6×10^{4}/g
	2/12	48 at 10^{-7}	4.8×10^{8}/g	34 at 10^{-4}	3.4×10^{5}/g	47 at 10^{-3}	4.7×10^{4}/g
RESIDUE	2/10	15 at 10^{-1}	1.5×10^{2}/g	3 at 10^{-1}	3.0×10^{1}/g	1 at 10^{-1}	1.0×10^{1}/g
	2/11	1 at 10^{-1}	1.0×10^{1}/g	1 at 10^{-1}	1.0×10^{1}/g	<1 at 10^{-1}	$<1.0\times10^{1}$/g
	2/12	39 at 10^{-1}	3.9×10^{2}.g	1 at 10^{-1}	1.0×10^{1}/g	0 at 10^{-1}	$<1.0\times10^{1}$/g
QUENCH WATER	*2/10	37 at 10^{-2}	3.7×10^{5}/100 ml	13 at 10^{-1}	1.3×10^{4}/100 ml	12 at 10^{-1}	1.2×10^{4}/100 ml
	2/11	43 at 10^{-3}	4.3×10^{6}/100 ml	35 at 10°	3.5×10^{3}/100 ml	13 at 10^{-3}	1.3×10^{3}/100 ml
	2/12	54 at 10^{-3}	5.4×10^{6}/100 ml	15 at 10^{-1}	1.5×10^{4}/100 ml	24 at 10°	2.4×10^{3}/100 ml
STACK	2/10	<1 per 100ml	$<.976/ft^{3}$	<1 per 1.0ml	$<97.6/ft^{3}$	<1 per 1.0ml	$<97.6/ft^{3}$
	2/11	<1 per 100ml	$.976/ft^{3}$	<1 per 1.0ml	$<97.6/ft^{3}$	<1 per 1.0ml	$<97.6/ft^{3}$
	2/12	Not Taken		Faulty Sampling Equipment			
FLY ASH	2/12	<1 at 10^{-1}	$<1.0\times10^{1}$/g	<1 at 10^{-1}	$<1.0\times10^{1}$/g	<1 at 10^{-1}	$<1.0\times10^{1}$/g
WELL WATER	2/11	8 at 10°	8.0×10^{2}/100 ml	1 at 10°	1.0×10^{2}.100 ml	0 at 10°	$<1.0\times10^{2}$/100 ml
	2/12	13 at 10^{-2}	1.3×10^{5}.100 ml	1 at 10°	1.0×10^{2}/100	0 at 10°	$<1.0\times10^{2}$/100ml

TABLE II - ENTERIC BACTERIOLOGICAL DATA ON INCINERATION STUDY, NEW ORLEANS, LA 2/10,11,12/69

		Total Coliforms		Fecal Coliforms		Salmonella
		Plate count	Calculated count	Plate count	Calculated count	
REFUSE	2/10	127 at 10^{-5}	1.3×10^{7}/g	29 at 10^{-5}	2.9×10^{6}/g	*Salmonella give Salmonella st. paul*
	2/11	42 at 10^{-5}	4.2×10^{6}/g	30 at 10^{-5}	3.0×10^{6}/g	Not Isolated
	2/12	L.A.		32 at 10^{-7}	3.2×10^{8}/g	Not Isolated
RESIDUE	2/10	0 at 10^{-1}	$<1.0 \times 10^{1}$/g	0 at 10^{-1}	$<1.0 \times 10^{1}$/g	Not Isolated
	2/11	0 at 10^{-1}	$<1.0 \times 10^{1}$/g	0 at 10^{-1}	$<1.0 \times 10^{1}$/g	Not Isolated
	2/12	0 at 10^{-1}	$<1.0 \times 10^{1}$/g	0 at 10^{-1}	$<1.0 \times 10^{1}$/g	Not Isolated
QUENCH WATER	2/10	46 at 10^{-1}	4.6×10^{4}/100 ml	43 at 10^{-1}	4.3×10^{4}/100 ml	Not Isolated
	2/11	17 at 10^{-1}	1.7×10^{4}/100 ml	40 at 10^{0}	4.0×10^{3}/100 ml	Not Isolated
	2/12	23 at 10^{-1}	2.3×10^{4}/100 ml	29 at 10^{0}	2.9×10^{3}/100 ml	Not Isolated
STACK	NOT DONE					
FLY ASH	NOT DONE					
WELL WATER	2/11	0 at 10 ml	<10/100ml	0 at 10ml	<10/100ml	Not Done
	2/12	0 at 10 ml	<10/100ml	0 at 10ml	<10/100ml	

TABLE III - CONVERSION OF REFUSE AND RESIDUE TO LOGS FOR FIGURE 1

(Total Bacterial Count and Spore Count)

REFUSE	TOTAL COUNT	LOG
	4.0×10^8	8.62
	2.1×10^7	7.32
	4.8×10^8	8.68
	AEROBIC SPORES	
	9.0×10^4	4.95
	3.5×10^4	4.54
	3.4×10^5	5.53
	ANAEROBIC SPORES	
	7.5×10^3	3.87
	1.6×10^4	4.20
	4.7×10^4	4.67
RESIDUE	TOTAL COUNT	LOG
	1.5×10^2	2.17
	1.0×10^1	1.00
	3.9×10^2	2.59
	AEROBIC SPORES	
	3.0×10^1	1.47
	1.0×10^1	1.00
	1.0×10^1	1.00
	ANAEROBIC SPORES	
	1.0×10^1	1.00
	$<1.0 \times 10^1$	<1.00
	$<1.0 \times 10^1$	<1.00

count and aerobic and anaerobic spore are plotted in Figure I. In addition to log values, the actual total bacterial and spore forming densities are shown on top of each bar of Figures I. The highest bacterial density from refuse is 4.8×10^8/gm. The highest bacterial density from residue is 3.9×10^2/gm. There is approximately a 10^6 reduction in total bacteria between the refuse and the residue. In the case of the spore formers, there is approximately a 10^5 reduction in aerobic spores and 10^3 reduction in anaerobic spores.

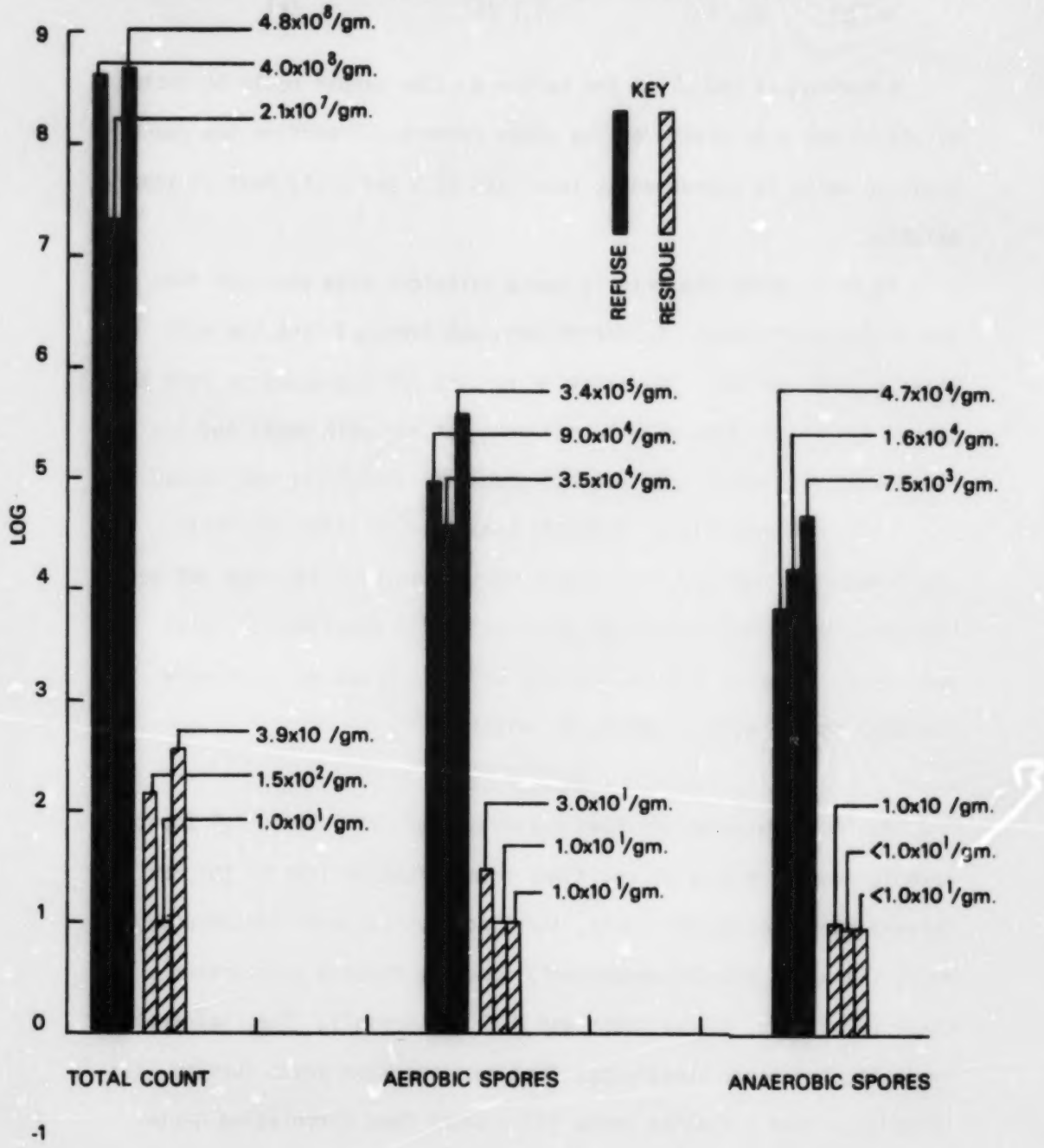
The analyses of the well water, quench water, fly ash, and stack emissions are also shown in Table I for counts of bacteria, aerobic spores and anaerobic spores. The well and the quench water counts are expressed in per 100 ml quantities.

No organisms were recovered from the fly ash. Since these tests are quantitative, the densities are expressed as less than ten per gram for the fly ash.

No organisms were isolated from the stack emissions. The bacterial count was done by the membrane filter method using 100 ml of the "inoculated" buffered water sample. When equated to cubic feet, the quantitative results is expressed as less than 0.976 per cubic foot. As previously stated 3.1 ft^3 of gas was impinged on 300 ml of buffered water. Therefore if less than one organism per 100 lm of sample was present, then less than 3 organisms per 300 ml of sample were present. Therefore:

FIGURE 1

COMPARISON OF BACTERIAL CONTENTS OF REFUSE AND RESIDUE



$$\left(\frac{3 \text{ organisms}}{300 \text{ ml}}\right)\left(\frac{300 \text{ ml}}{31. \text{ ft}^3}\right) = \left(\frac{3 \text{ organisms}}{3.1 \text{ ft}^3}\right) = \frac{0.976 \text{ organisms}}{\text{ft}^3}$$

A maximum of one ml of the buffered water sample could be tested by use of the pour plate for the spore formers. Therefore the quantitative value is expressed as less than 97.6 per cubic feet of stack emission.

Table II shows the enteric bacteriological data obtained from the incinerator study. Coliforms were not isolated from the well water or the residue. Quantitative results are expressed as less than 10 per 100 ml and less than 10 per gram for the well water and the residue respectively. Fly ash and stack emissions were not tested for intestinal organisms. Moderate densities of total and fecal coliforms were isolated from quench waters; salmonellae were not recovered. The refuse contained relatively high densities of total and fecal coliforms. *Salmonella give* and *Salmonella st. paul* were isolated from a 30 gram sample of refuse.

DISCUSSION

Table IV contains arithmetic averages of total bacterial counts, aerobic spores, and total coliforms from refuse/residue of the New Orleans East Incinerator study, the Cincinnati-Chicago incinerator study (Peterson and Stutzenberger[6]), and the Memphis Incinerator study (Armstrong, D., J. Klass and M. L. Peterson[2]). The incinerator types studied were: continuous feed reciprocating grate furnace (I); continuous feed traveling grate (II); batch feed circulating grate (III); continuous feed rotary kiln (IV); batch feed reciprocating

TABLE IV-COMPARISON OF THE NEW ORLEANS EAST INCINERATOR STUDY WITH STUDIES OF OTHER INCINERATORS

	NEW ORLEANS EAST	CINCINNATI-CHICAGO*	MEMPHIS
TOTAL COUNT			
Refuse/Residue	I $3.0 \times 10^8 / 2.1 \times 10^2$	II $1.1 \times 10^8 / 9.0 \times 10^7$	VI $6.6 \times 10^8 / 2.4 \times 10^4$
		III $4.5 \times 10^8 / 1.1 \times 10^7$	
		IV $7.8 \times 10^7 / 2.3 \times 10^6$	
		V $4.8 \times 10^8 / 1.3 \times 10^4$	
AEROBIC SPORES			
Refuse/Residue	I $1.6 \times 10^5 / 1.7 \times 10^0$	II $2.7 \times 10^5 / 1.9 \times 10^5$	VI $1.9 \times 10^6 / 4.7 \times 10^3$
		III $1.1 \times 10^5 / 2.9 \times 10^4$	
		IV $3.8 \times 10^4 / 9.7 \times 10^3$	
		V $3.1 \times 10^4 / 5.6 \times 10^3$	
TOTAL COLIFORMS			
Refuse/Residue	I $8.6 \times 10^6 / < 1.0 \times 10^1$	II $3.0 \times 10^6 / 1.2 \times 10^5$	VI $5.1 \times 10^7 / 1.7 \times 10^1$
		III $6.7 \times 10^6 / 2.8 \times 10^2$	
		IV $1.6 \times 10^6 / 1.2 \times 10^2$	
		V $6.3 \times 10^5 / 4.0 \times 10^0$	

*Arithmetic data from work of Peterson and Stutzenburger (1969) recalculated from geometric means.

grate (V); and a conical (VI). Total coliforms for the New Orleans study was done by the membrane filter method, whereas the MPN tube method was used for the others. Comparisons are therefore made on a qualitative basis. Since the methodology in all studies were the same for total counts and aerobic spores, this data may be compared quantitatively.

The New Orleans East study (I, $3.8 \times 10^8/2.1 \times 10^2$) averaged a millionth fold reduction for total bacterial count of refuse/residue per gm of material tested. For the Cincinnati-Chicago studies, (V, $4.8 \times 10^8/1.3 \times 10^40$, averaged a 37 thousand fold reduction. The remaining furnaces II, III, and IV averaged a 1 to 40 fold reduction. In the Memphis study (VI, $6.6 \times 10^8/2.4 \times 10^4$), an approximate 27 thousand fold reduction was obtained in the refuse/residue per gm of material tested.

For the aerobic spores, a 100 thousand, ten-thousand, and a thousand fold reduction from New Orleans East, Cincinnati, Chicago, and the Memphis studies respectively, were obtained.

Coliforms were not recovered from the New Orleans East incinerator residue, but were recovered from residues of the other two studies.

The burning efficiency of the New Orleans incinerator, relative to reduction of bacteria, appears superior as compared with the others cited in Table IV.

For all practical purposes, the fly ash and stack emissions may be deemed bacteriologically benign. The fact that coliforms were

recovered from the quench water, but were not recovered from either the residue or well water, indicated subsequent contamination of the quench water possibly from equipment.

The isolation of coliforms (intestinal organisms) from refuse and quench water indicates the presence of fecal contamination. Although the coliforms are generally considered harmless, they indicate the presence of fecal material with the attendant hazard of enteric pathogens. The recovery of *Salmonella give* and *S. st. paul* February 10, is positive proof of the health hazard associated with domestic refuse.

SUMMARY

The burning efficacy of the New Orleans East incinerator, as indicated by organisms in refuse and in residue, is shown to be of high quality as compared with other incinerator studies. A comparison of the organisms in refuse and in residue showed a million fold destruction of total organisms per gram of material tested. Quantitation of heat resistant aerobic and anaerobic spores was also used as a measuring "tool" for ascertaining burning efficiency. An average of 1 thousand to 100 thousand fold reduction of spores from the burned refuse was obtained.

Fecal coliform organisms as high as 3.2×10^8 per gram of refuse was recovered, indicating fecal contamination with the attendant hazard of pathogens. Salmonellae, enteric pathogens, were recovered from as little as 30 grams of refuse. This is positive proof of the deleterious quality of refuse.

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